User Guide of Cargo Data Miner

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Contents

Abstract

This is the user guide of *Cargo Data Miner*. *Cargo Data Miner* is an R-Shiny Dashboard application developed by Airbus Freighter Marketing department (CSMX). The initiative is to build a platform where everybody could query and analyze cargo data. In this document, detailed information and instruction are provided in order to facilitate the usage and maintenance of the application. For more information, the author could be reached at xuzhou.qin@gmail.com.

Acknowledgement

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1 Introduction

Aviation market is a highly complex and data-dependent market. Inside Airbus, numbers of different servers are deployed to stock, manage and provide database services to support our daily work. It is striving to introduce data digitalization as a core task of its future plan. The raising importance of data has already grabbed the attention of the managers and it will never stop growing. However, face to the massive amount of data, challenge still remains.

At the company level, the main challenge comes from the database management. Too many databases are stocked seperately with different **database management system** (DBMS). The databases are quite isolated from the others. In other words, except people who frequently use one database, others could not even know its existence. Then, the different DBMS cause inconvinience in database management. For example in the freighter marketing department (CSMX), three marketing databases, *Cargo IS*, *Seabury* and *FlightRadar 24* are stocked separately in three data servers using three different DBMS (Oracle Database, MySQL and Microsoft SQL server).

At the department level, the major challenge is the lack of an efficient and user-friendly tool for the data extraction and analysis process. Even thought the traditional approach of database management, SQL, is widely used for data manipulation. But in order to use it efficiently, you must have some knowledge of programming and you have to suffer the difficulty in interfacing. As SQL is not a common tool inside marketing department, interacting with the data by using SQL may not be a suitable choice. As to the data analysis tool, Excel is one of the most widly used software. But it suffers from some innate limitations facing the increasing amount of data.

There are also some Airbus-made tools for marketing department, like *Acper*, *OAG Builder*, *route06*, etc. These are very powerful and sophisticated programs dedicated for specific usage since a very long time. They are irreplaceable for some tasks but they are still not perfect. For example, in terms of learning difficulty, they both have a steep learning curve. Some special training session are needed to master these tools. And from a graphical design's point of view, they often remind me about the "old fashioned" software interface, which may be not enough intuitive and user-friendly. The need to visualize the analytic results in a modern way is thus urgent.

Due to these facts, data digitalization inside Airbus should be done from two level. We will need an uniform and standardized plateform to stock and manage data at the company level. And inside the departments, new data mining and analysis tools are needed to support the works in the big data era. Some moves have already been realised inside Airbus. **BIO** is a platform which provide an automatic aggregation of different databases. **Foundry** is a cloud-based platform for collaboratively big data analysis built by Palantir Technologies.

This document provide a solution for the development of a data analysis tool by using **R Shiny Dashboard**. **Shiny Dashboard** is a framework to create a light weight, powerful and interactive web application. It uses a reactive programming model so that outputs change instantly as users modify inputs. It is esay to use, no web designing language required. But further customization could be easily done with some HTML, CSS and JavaScript knowledge.

In the first section of this document, installation and deployment prerequisites are presented. Then, detailed fonctionalities and the application structure are stated in section two in order to provide technical support for using and maintenance. In the third section, some suggestions for the future development of this application are proposed. The technical appendix could be found in the last section of the document.

2 Prerequisites

Cargo Data Miner (CDM) was developped with **Microsoft R Open 3.2.5**, which is a enhanced distribution of R. It support by defaut multi-thread computing and it is perfectly compatible with the original **R**. The user interface used during the development is **RStudio**, which the the most common IDE of R.

To make **CMD** work properly, there are two main methods.

– Install and run it locally on a PC for personal use.

– Deploy it on a Shiny server so that CDM could be reached by an IP adress.

In this section, I will present both the two methods.

2.1 Directory Structure

The following figure presents the structure of the CDM directory.

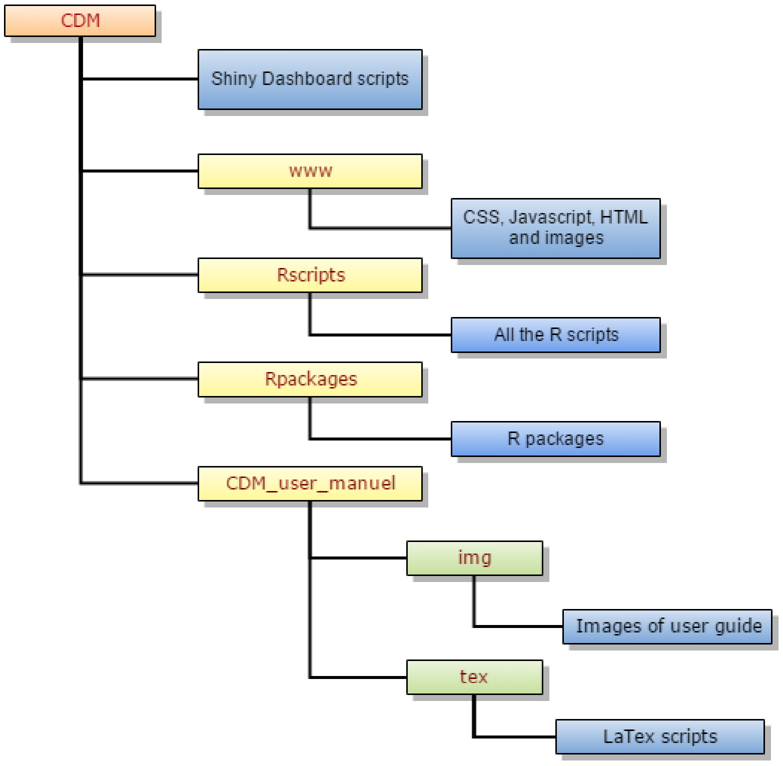


Figure 1: CDM directory structure

The main directory `~/CDM` contains Shiny Dashboard scripts (*ui.R*, *server.R* and *global.R*) and three directories:

- `/www`
- `/Rscripts`
- `/Rpackages`
- `/CDM_user_manuel`

All the images, HTML, CSS and JavaScript used in **CDM** should be placed in `~/CDM/www`. All the R scripts called by the application should be placed in `~/CDM/Rscripts` and all the R packages (for local installation) should be placed in `~/CDM/Rpackages`.These three directories are the essential parts of **CDM**.

In `~/CDM/CDM_user_manuel`, you will find the code of this use guide (written in R markdown) and its resources. All figures appeared in this document should be placed in `~/CDM/CDM_user_manuel/img` and all the LaTex scripts called from the R markdown code will be found in `~/CDM/CDM_user_manuel/tex`.

2.2 Installation on a PC

CDM could run on a personal computer having installed R and a web browser with the correct configuration. Before the first use, some steps have to be followed.

- Step 1: Get R and other required software:
  - Install **Microsoft R Open 3.2.5** from https://mran.revolutionanalytics.com/download/ (to turn on the multi-thread computing support, install the MLK package as well), or you can install the original **R** (64-bit) from https://cran.r-project.org/mirrors.html.
  - Install **RStuido** from https://www.rstudio.com/products/rstudio/. This is optional but highly recommanded.
  - **CDM** works with Internet Explorer but you could also install Google Chrome for the best performance.
  - Install **Oracle Database Instant Client (11.2.0.3) EN_W764** from PC service. Or you can download it from Oracle website (Make sure it is the 64-bit version). If error of Oracle occurs during the execution of **CMD**, see Appendix: Troubleshooting for help.
- Step 2: Connection Setup
  - **CMD** will need the access right of three different databases. They are: **p595dodmp01** (Cargo IS, Seabury), **fr0-bio-p01** (BIO) and **fr0-dmds-p01** (FlightRadar 24). The user name and password are already pre-filled and there is no need to change, except for **BIO** database. Because you will need to grant the access right to your own *Windows* account to make the connection. To do so, you could ask *Aurelien Turina* for further information.
  - `~/CDM/global.R` contains the connection parameters of these databases.

```
##########################################################
#' CONNECTION PARAMETERS
#'
#' Modify it before the first execution of the application
##########################################################
#' ROracle connection string
#' for Cargo IS, Seabury
host = 'p595dodmp01'
port = 1521
sid = 'DBUPA269'
username_cargois <- 'CARGO'
password_cargois <- '********'


#' RODBC MS SQL server connection string
#' for BIO
driver_bio <- 'SQL Server'
server_bio <- 'fr0-bio-p01'
port_bio <- 10335
username_bio <- ''
password_bio <- ''
trusted_connection_bio <- TRUE # if TRUE connect with windows login and pw


#' RMySQL MySQL connection string
#' for FlightRadar 24
```

```
user_fr24 <- "user_ext"
password_fr24 <- "************"
dbname_fr24 <- 'FR24'
host_fr24 <- "fr0-dmds-p01"
```

- Step 3: Now you can open RStudio.
  - Before running **CDM**, if you have more than one version of R installed on your computer, make sure that the R version is `[64-bit] ~/MRO_3.2.5` (the name could be varied)
  - Click on the **run** button on the top right of the text editor aera to execute the application. The application will automatically check if all the required R packages are installed and it will install those which are not installed from **CRAN** (Comprehensive R Archive Network). **CRAN** is a network of ftp and web servers around the world that store identical, up-to-date, versions of code and documentation for R. However, due to the internet connection configuration inside Airbus, if any of the required packages fails to download, you will have to download and install it manuelly (See Appendix for detail).

Now you are ready to use **CDM** :)

2.3 Deployment on a Shiny Server Pro

Shiny Server Pro is a server program that makes Shiny application available over the web.

At this time, Shiny Server can be run on Linux servers with explicit support for Ubuntu 12.04 or greater (64 bit) and CentOS/RHEL 5 (64 bit) or greater. Multiple Shiny applications on multiple web pages could be hosted with the same Shiny Server.

It can be downloaded from https://www.rstudio.com/products/shiny/shiny-server/.

For the detail instruction of the configuration and installation of Shiny Server Pro, see **Shiny Server Professional v1.4.2 Administrator's Guide** on http://docs.rstudio.com/shiny-server/.

3 Structure and Features

A Shiny dashboard application could contains three sources scripts:

- a user-interface script: `ui.R`
- a server script: `server.R`
- a global environment script: `global.R`

There is another structure of Shiny application where all the three main scripts could be integrated into one single scipt `app.R`. But here we only talk about the "traditional" structure.

The UI script controls the layout and appearance of the app. The server script contains the instructions that your computer needs to build your app. And the glabal script defines objects in the global scope.

Reactivie programming is the fundamental of a Shiny Dashboard application. The main idea is to make it easy to wire up *input values* from a web page, trigger the R code to be (re)executed, and then have the results of your R code be written as *output values* back to the web page.

The following figure shows the three elements in Shiny reactive programming. **Reactive source** typically is the user's input through a web browser. It could trigger the execution of an R code. The output of the code is represented by the **reactive endpoint**. **Reactive conductor** could be placed between the sources

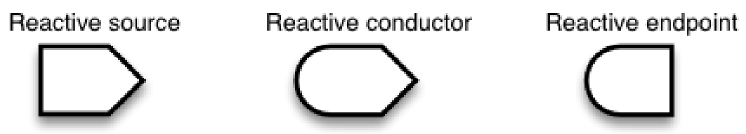
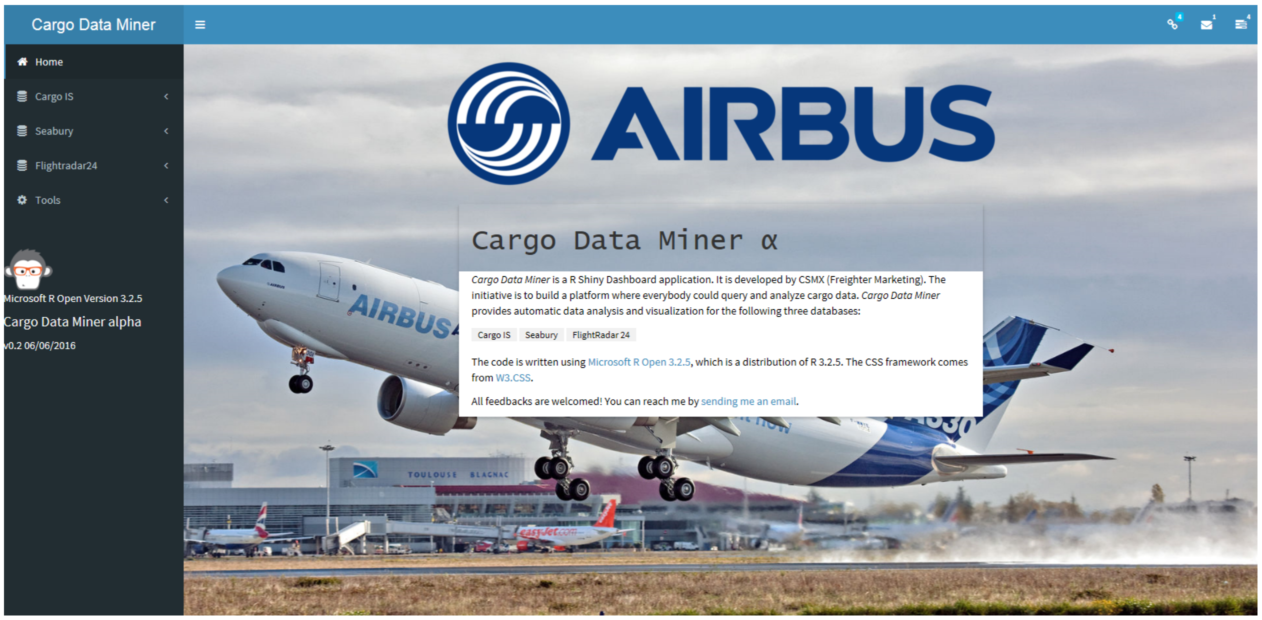


Figure 2: Essential objects in reactive programming

and endpoints. Generally they are used to encapsulate the computationally expensive operations in order to augment the code performance.

After launching **CDM**, you will see the following welcome page. **CDM** has three parts: a header, a sidebar and a body. The header show the application name and some notification[1], for example the database connection status, the app version and the developing progres. The sidebar could help you to navigate between different tabs The functionalities of these widgets will be presented in the following sections. Finally the body is the main aera where you will be able to interact with **CMD** and see the output.



Cargo Data Miner α

Cargo Data Miner is a R Shiny Dashboard application. It is developed by CSMX (Freighter Marketing). The initiative is to build a platform where everybody could query and analyze cargo data. *Cargo Data Miner* provides automatic data analysis and visualization for the following three databases:

Cargo IS Seabury FlightRadar 24

The code is written using Microsoft R Open 3.2.5, which is a distribution of R 3.2.5. The CSS framework comes from W3.CSS.

All feedbacks are welcomed! You can reach me by sending me an email.

Figure 3: **CMD** home page

Five different tabs are displayed on the sidebar. Each tab contains also several subtabs.

3.1 Cargo IS Database

Cargo IS database is the first major conponent of **CDM**. It provides airport level Air Waybill data, including airfreight charges, weight, numbers of shipmens and it is the only ressource of cargo yield information for Airbus.

3.1.1 Data loader

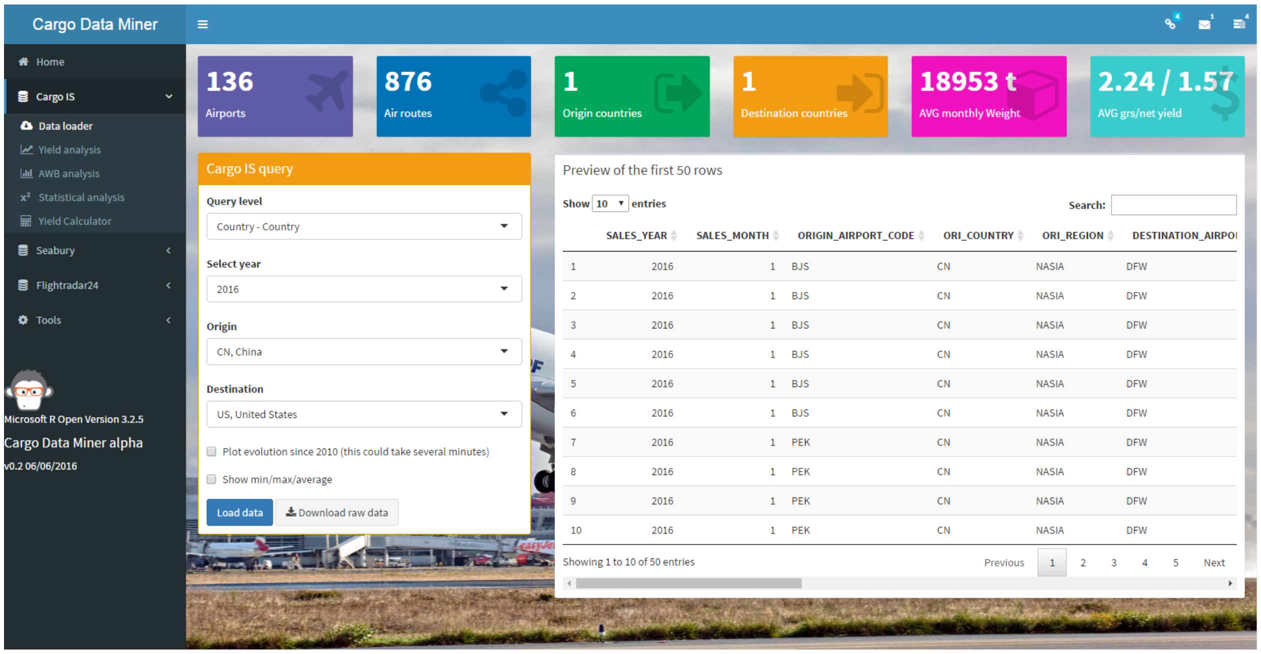
3.1.1.1 Instruction

[1]Some features are still under development.

The first step is about how to load Cargo IS data. In the first dropdown menu, we could select the level of data granularity to be queried from Cargo IS (*e.g.*, airport to airport, country to country, region to region, etc). Then the year and the **O&D** (**O**rigin and **D**estination) of airfreight should be precised. You can check the box *"Plot evolution since 2010"* to load data of all the available year (2010-2016). When the box is checked, the year input will be ignored.

After selecting the right parameters, click on **Load Data** buttom. Some summerize of the queried dataset will be shown on the top of this tab. A preview of the 50 first rows will appear on the right. You could do a quick check of the data. The data table could be downloaded by simply clicking on the **Download Data** button.

Now the data table is loaded and ready to be used!



136 Airports

876 Air routes

1 Origin countries

1 Destination countries

18953 t AVG monthly Weight

2.24 / 1.57 AVG grs/net yield

Cargo IS query

Query level: Country - Country

Select year: 2016

Origin: CN, China

Destination: US, United States

☐ Plot evolution since 2010 (this could take several minutes)

☐ Show min/max/average

Load data | Download raw data

Preview of the first 50 rows

Show 10 entries — Search:

	SALES_YEAR	SALES_MONTH	ORIGIN_AIRPORT_CODE	ORI_COUNTRY	ORI_REGION	DESTINATION_AIRPO
1	2016	1	BJS	CN	NASIA	DFW
2	2016	1	BJS	CN	NASIA	DFW
3	2016	1	BJS	CN	NASIA	DFW
4	2016	1	BJS	CN	NASIA	DFW
5	2016	1	BJS	CN	NASIA	DFW
6	2016	1	BJS	CN	NASIA	DFW
7	2016	1	PEK	CN	NASIA	DFW
8	2016	1	PEK	CN	NASIA	DFW
9	2016	1	PEK	CN	NASIA	DFW
10	2016	1	PEK	CN	NASIA	DFW

Showing 1 to 10 of 50 entries — Previous 1 2 3 4 5 Next

Figure 4: An example query of the 2015 airfreight from *China* to *the USA*.

3.1.1.2 Explaination

The data loading procedure will call the `CargoIS.SQL.query` function. The function will take the user parameters as inpus, generate an appropriate `Oracle SQL` code and send the query to the data server. The returned dataset is thus stocked in the global scope and it is ready to be used by other functions.

```r
# EXAMPLE
# Query airfreight data of 2015 with origin country = China, destination = USA
dat <- CargoIS.SQL.query(CargoDB, level = 'C2C',
                         ORG = 'CN',
                         DST = 'US',
                         year = 2015)
```

The six value boxes on the top of the page are created by the function `valueBox(value, subtitle, icon, color, width, href)` based on the output dataset. They represent:

- **Airports**: Numbers of unique airports appeared in the dataset.
- **Air routes**: Numbers of unique airport pairs (Origin + Destination) in the dataset.

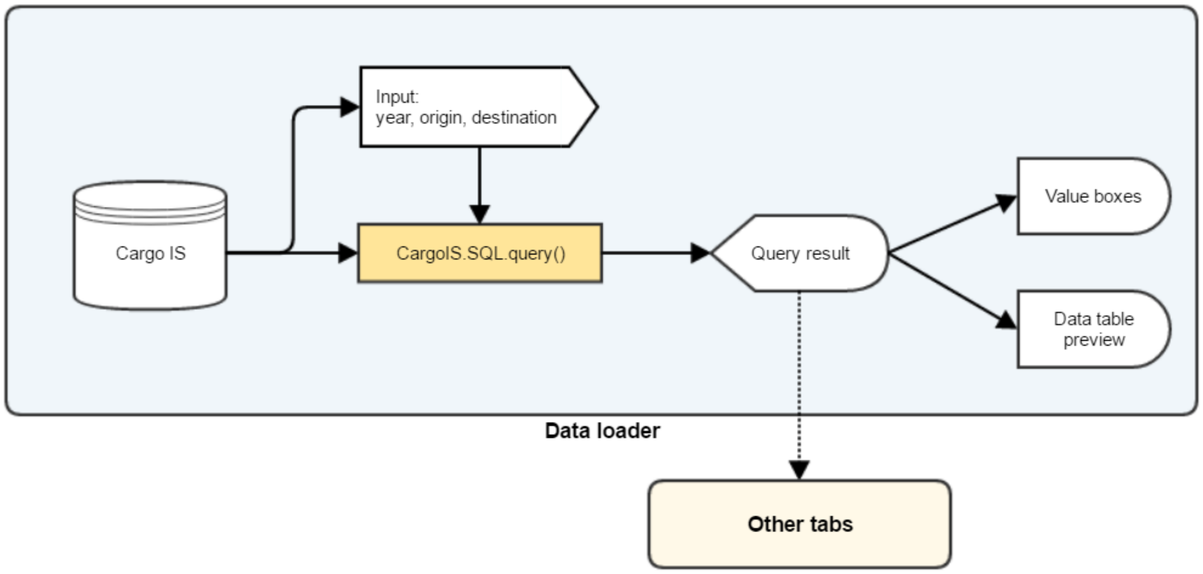


Figure 5: Flowchart of data loading process

- **Origin country**: Numbers of unique origin country(ies).
- **Destination country**: Numbers of unique destination country(ies).
- **AVG monthly weight**: Arithmetic mean of weight.

$$Average\ monthly\ weight = \frac{\sum_{i=1}^{n}\sum_{j=1}^{m} weight_{ij}}{n}$$

  , where i is the number of months, j is the weight break.
- **AVG gross/net yield**:

$$Average\ gross\ yield = \frac{\sum_{i=1}^{n}\sum_{j=1}^{m} charges_{ij} + surcharges_{ij}}{\sum_{i=1}^{n}\sum_{j=1}^{m} weight_{ij}}$$

$$Average\ net\ yield = \frac{\sum_{i=1}^{n}\sum_{j=1}^{m} charges_{ij}}{\sum_{i=1}^{n}\sum_{j=1}^{m} weight_{ij}}$$

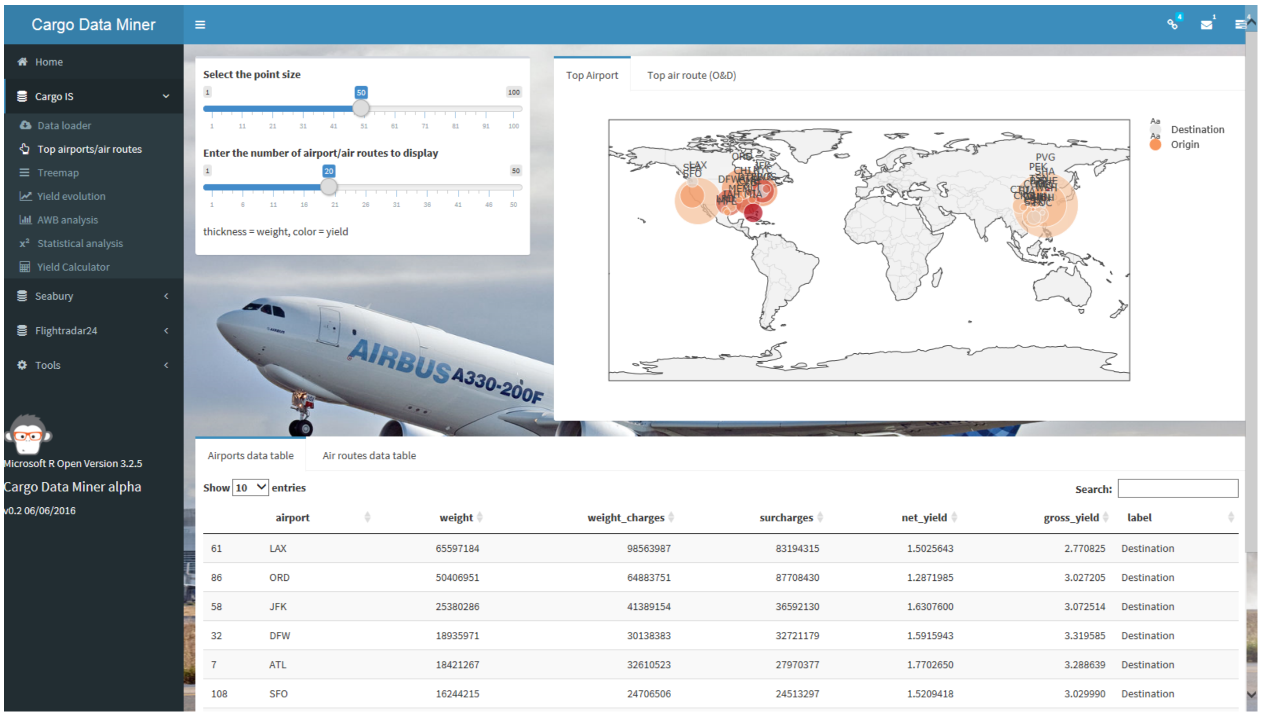
, *charges* are fees directly related to the weight of the shipment and *surcharges* contain all the other fees (fuel surcharges, security surcharges, taxes, etc.)

3.1.2 Top airports/air routes

When the data loading procedure is complete, you can go to the following tabs to see some visualization output. After clicking on the "Yield Analysis" tab, **CDM** will automatically proceed and visualize the loaded dataset.

3.1.2.1 Instruction

The first part of tab contains visualization of the **top *n* airports and air routes**. Figure 6 shows in the map the top 20 origin and destination airports. The surface of the circle represents the weight of shipment going through this airport. The darkness of the color represents the yield of the airport. The charts are



Select the point size: 50

Enter the number of airport/air routes to display: 20

thickness = weight, color = yield

Show 10 entries

	airport	weight	weight_charges	surcharges	net_yield	gross_yield	label
61	LAX	65597184	98563987	83194315	1.5025643	2.770825	Destination
86	ORD	50406951	64883751	87708430	1.2871985	3.027205	Destination
58	JFK	25380286	41389154	36592130	1.6307600	3.072514	Destination
32	DFW	18935971	30138383	32721179	1.5915943	3.319585	Destination
7	ATL	18421267	32610523	27970377	1.7702650	3.288639	Destination
108	SFO	16244215	24706506	24513297	1.5209418	3.029990	Destination

Figure 6: Yield Analysis tab, top 20 airports of CN-US

interactive, you can zoom in/out with the mouse scroll wheel. You can also click on the legend to display/hide the origin/destination airports.

The value of n could be modified by dragging the slider bar. You could also modify the size of the circle if sometimes the defaut size is too big/small.

The **Top air routes (O&D)** tab of the visualization chart shows the weight and yield of the most important air routes. Origin and destination airports are linked by blue curves with different thickness and darkness. The **thicker** the curve, the **more** the total weight and the **darker** the blue, the **higher** the yield.

The last two tabs (Airports data table and Air routes data table)show the two data tables that **CDM** uses to create the map. It could be sorted by variables and it could be directly copy-pasted into an Excel sheet.

3.1.2.2 Explaination

An R package `Plot_ly` was used to create the visualization map. From `/Scripts/Plot.airport.html.R`, an user defined function `Plot.airport.html()` is called.

```
#' [Plot.airport.html] could be used to visualize the top n airports/air routes
#' When the parameter table = TRUE, it will output the datatable that it will
#' use for the data visualization.
#'
#' @param dataset: data frame with five columns
#' c('ORIGIN_AIRPORT_CODE', 'DESTINATION_AIRPORT_CODE', 'WEIGHT_CURRENT_YEAR',
#' 'WEIGHT_CHARGES_CURR_YEAR_USD', 'OTHER_CHARGES_CURR_YEAR_USD')
#'
#' @param projection: Mercator or orthographic
#'
#' @param top: numbers of airport/air routes to be displayed
#'
```

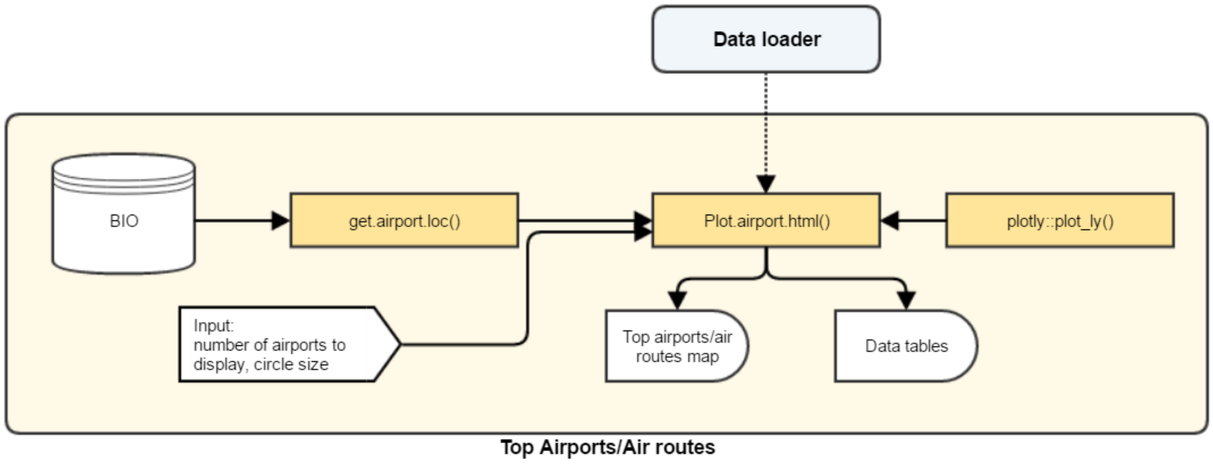


Figure 7: Flowchart of top airports/air routes tab

```r
#' @param plot.airport: if TRUE, plot airport, if FALSE, plot air routes
#'
#' @param pt.size: int, point size
#'
#' @param table: if TRUE, output datatable, otherwise, output map

 Plot.airport.html(dataset, projection = 'Mercator', top = 20, plot.airport = TRUE,
                   pt.size = 800000, table = FALSE)
```

`Plot.airport.html()` will call `plotly::plot_ly()`. `plotly::plot_ly()` provides a simple way to add scatters/lines/curves to a map. It will only need the coordinates of the O&D airports, which we could easily get from BIO database by doing

```r
source('/Scripts/get.airport.loc.R')
get.airport.loc()
```

Figure 7 shows how the function `plot.airport.html()` works.

3.1.3 Treemap

3.1.3.1 Instruction

The tab **Treemap** visualizes the relationship between different **nodes** (airports, countries and regions). Each node is displayed as a rectangle, sized by the total airfreight weight of this node and colored by the average gross yield of the node.

You can click on the rectangle to see its child nodes[2] (if exist), and right-click to see its parent node. A scale is shown on the top right to indicate the yield level. The tab **Table** will render the used data table for the visualization. The table contains four columns, *Name*, *Parent*, *Weight*, *GrossYield*.

Currently there is no fitable solution to generate a static downloadable image. So you may take a screen shot if you want to add the chart to your slides.

[2]For example, **country** is the child node of **region**, and it is the parent node of **airport**.

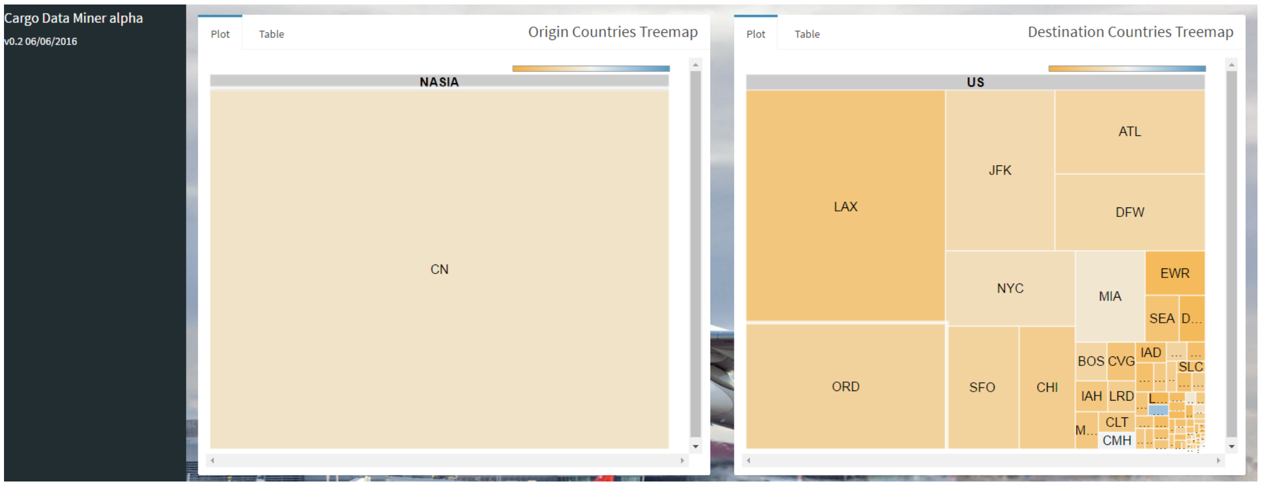


Figure 8: Treemap of airports for CN and US

3.1.3.2 Explaination

To create an interactive treemap, I created an user-defined function `treemap_cargois_gvis()`, which will call `googleVis::gvisTreeMap()`. The package `googleVis` is the R interface to **Google Charts API**. It generates an HTML code which could be integrated into R Shiny application. It could be further customized by using Javascripts.

```
# Example:
treemap_cargois_gvis(data, ORG = FALSE, PLOT = TRUE)

#' data is a data.frame object generated by Cargois.SQL.query()
#' If ORG = TRUE, then create treemap for the origin airports,
#' else for the the destination airports
#' If PLOT = FALSE, then the output will be a data.frame object
#' (instead of a plot)
```

The function `treemap_cargois_gvis()` will convert the queried Cargo IS data table into a four-column dataset (*Name*, *Parent*, *Weight*, *GrossYield*), which could be used by `googleVis::gvisTreeMap()`.

```
# Example of gvisTreemap
gvisTreeMap(data = datatable, idvar = 'Name', parentvar = 'Parent', sizevar = 'Weight',
                colorvar = 'GrossYield',
                options=list(fontSize=16,
                             minColor='#F5B041',
                             midColor='#F0F3F4',
                             maxColor='#5499C7',
                             headerHeight=20,
                             fontColor='black',
                             showScale=TRUE)
                            # options, see
                            # https://developers.google.com/chart/interactive/docs/
            )
```

3.1.4 Yield Evolution

Yield is the most important information provided by Cargo IS database.

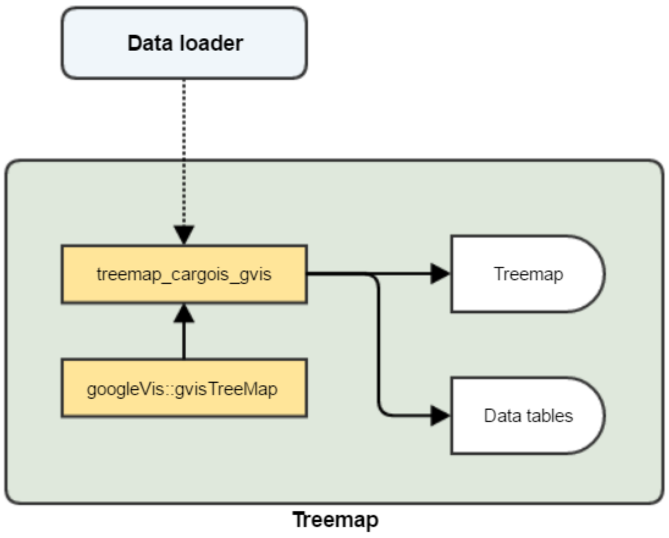


Figure 9: Flowchart of Treemap tab

3.1.4.1 Instruction

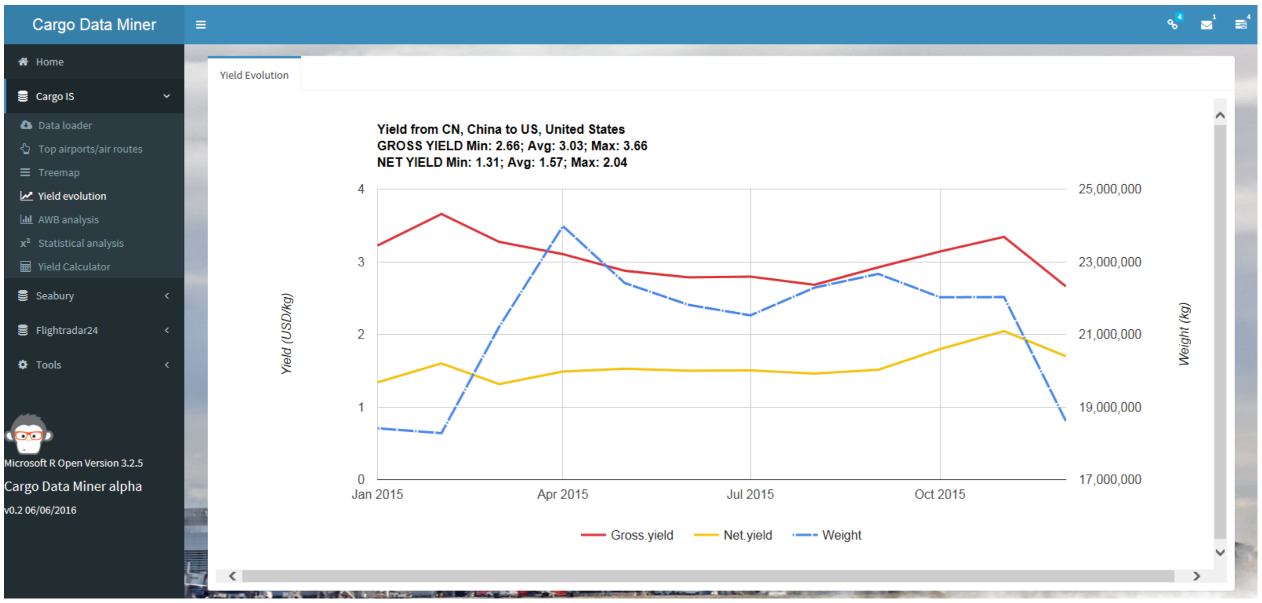


Figure 10: Airfreight weight and yield evolution for CN and US

The next tab **Yield evolution** generates an airfreight evolution plot. **CDM** calculates and render a line chart showing the evolution of gross yield, net yield and airfreight weight during the selected period of time. The minimum, maximum and average value of the output are shown in the plot's subtitle.

The x-axis represents the available months during the selected period. If the box "Plot evolution since 2010" in the data loaded page is checked, all the available data will be visualized (but the computing will also take a longer time).

You could click on the curve to see detailed information of the choosen data point.

A data table appears on the bottom of the page. It contains all the data of the line chart. You could click on the download button to save it to the local.

3.1.4.2 Explaination

I would like to integrate the three curves (net yield, gross yield and weight) into one sigle chart. Thus two different y-axis are needed. The well known package `ggplot2` does not support two different y-axis in one chart so I will still use `googleVis` to generate the line chart.

```r
# Example of givsLineChart
# with gvisLineChart, we could easily create a line chart with 2 y-axis

gvisLineChart(data, xvar = "xaxis", yvar = c('yaxis_1', 'yaxis_2', 'yaxis_3'),
              options = list(series="[
                              {targetAxisIndex: 0}, # set the target y-axis
                              {targetAxisIndex: 0},
                              {targetAxisIndex: 1}
                              ]"
                            )
              )
```

3.1.5 Air Waybill Analysis

An **air waybill** is a receipt issued by an international airline for goods and an evidence of the contract of carriage. It is the most important document issued by the carrier (directly of throught an authorised agent). Cargo IS contains the records the weight data and it regroups the air waybills into six categories, which are called **weight breaks**, regarding to its weight.

They are:

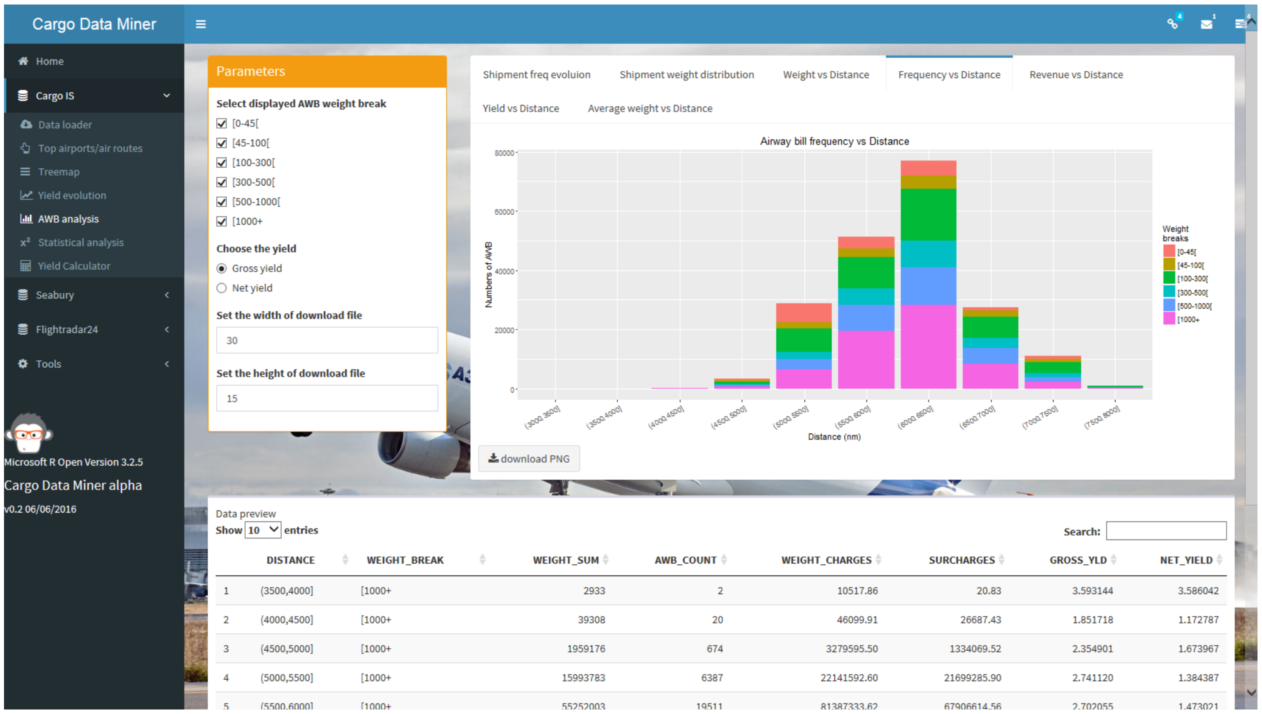
- 0 to 50 kg
- 50 to 100 kg
- 100 to 300 kg
- 300 to 500 kg
- 500 to 1000 kg
- larger than 1000 kg

The proportion of the AWB of different categories in a market could be an indicator of the economic situation. For example, an increasing number of heavy shipments often means the cargo consolidation becomes more efficient, and the economic situation is going better.

3.1.5.1 Instruction

The first row of this tab contains seven figures:

- *Shipment frequency evolution* is a line chart which shows how the numbers of shipments change during the selected period. By defaut, there will be six curves representing repectively the different weight break.
- *Shipment weight distribution* is a bar chart which shows the distribution of the AWB of different weight break in the selected period.
- *Weight vs. distance* is a stacked bar chart showing the sum of shipment weight by different intervals of distance. The colors represent the different weight breaks.
- *Frequency vs. distance*: like the previous figure, it shows the numbers of shipments by different intervals of distance.



Parameters

Select displayed AWB weight break
- ✓ [0-45[
- ✓ [45-100[
- ✓ [100-300[
- ✓ [300-500[
- ✓ [500-1000[
- ✓ [1000+

Choose the yield
[✓ Gross yield] Net yield

Set the width of download file: 30

Set the height of download file: 15

Data preview
Show 10 entries Search:

	DISTANCE	WEIGHT_BREAK	WEIGHT_SUM	AWB_COUNT	WEIGHT_CHARGES	SURCHARGES	GROSS_YLD	NET_YIELD
1	(3500,4000]	[1000+	2933	2	10517.86	20.83	3.593144	3.586042
2	(4000,4500]	[1000+	39308	20	46099.91	26687.43	1.851718	1.172787
3	(4500,5000]	[1000+	1959176	674	3279595.50	1334069.52	2.354901	1.673967
4	(5000,5500]	[1000+	15993783	6387	22141592.60	21699285.90	2.741120	1.384387
5	(5500,6000]	[1000+	55252003	19511	81387333.62	67906614.56	2.702055	1.473021

Figure 11: Air waybill analysis

- *Revenu vs. distance* shows the revenus (charges) of airfreight by different intervals of distance.
- *Yield vs. distance* is a line chart showing the gross/net yield of by weight breaks and by diatance.
- *Average weight vs. distance* takes into accout all the weight breaks and compute the weighted arithmetic mean of weight by distance.

For the charts 3, 4 ,5 and 6, if there is only one interval of distance, a pie chart will be created instead of a bar chart. All the charts can be downloaded by clicking "download PNG" button.

On the left of the charts, some parameters can be changed to modify the charts. You can display/hide one or multiple weight break(s) by checking/unchecking the boxes. The second part "gross yield/net yield" corresponds to the yield type in the chart *Yield vs. distance*. The last two text input aera control the width and height of the downloaded image.

On the bottom of the page, the data table used for creating the charts is displayed. It could also be downloaded by clicking the download button.

3.1.5.2 Explaination

Before creating the charts, data manipulation should be done in order to have the right data to plot. `data.table` is a very powerful package for big data computing.

```r
# Example of data.table

system.time(
  output <- dt[,.(weight = sum(WEIGHT_CURRENT_YEAR),
                  freq = sum(AWB_COUNT_CURRENT_YEAR),
                  wchg = sum(WEIGHT_CHARGES_CURR_YEAR_USD),
                  surchg = sum(OTHER_CHARGES_CURR_YEAR_USD),
                  gy = (sum(WEIGHT_CHARGES_CURR_YEAR_USD)+
                           sum(OTHER_CHARGES_CURR_YEAR_USD))/sum(WEIGHT_CURRENT_YEAR),
                  ny = (sum(WEIGHT_CHARGES_CURR_YEAR_USD))/sum(WEIGHT_CURRENT_YEAR)
                  ), by = .(dist = lebal, wb = WEIGHT_BREAK)
                ]
)
# dt is a 1 750 000*15 data.table,
# user  system elapsed
# 0.14    0.00    0.14
```

To create these charts, the package `ggplot2` is extensively used.

3.1.6 Yield Calculator

The last subtab of Cargo IS is a marketing tool called yield calculator, which offers an automatic computing for air route cargo yield. It will read air routes from a `csv` file (uploaded by user), query *Cargo IS* database and display a data table with weight and yields of every air route in the uploaded list, as well as a air route map visualizing all the air routes by their cargo weight and cargo yield.

3.1.6.1 Instruction

The idea of yield calculator is to get rid of manual cargo yield computing. To use yield calculator, you will need to create a `csv` file containing two columns: "From" and "To", which correspond to the origin and destination airport. Once the `csv` is ready, you could upload it to **CDM** by clicking **choose file** button. Then, the year parameter should be selected. The others parameters could be modified if according to the format of your `csv` file. When everything is done, click on *Start*.

A data table will be displayed after the computing. The gross yield, net yield, weight, gross charges and net charges will be calculated for each air route. On the bottom, an air routes map will show the input air routes by the cargo weight and cargo yield. The darker the curve, the higher the yield. The thicker the curve, the higher the cargo weight. Click on "Download" to download the data table. It will be a `csv` file as well.

There may be rows only containing value **zero** in the output table. It is because of the lack of data in Cargo IS database. We do not have any information about the given air route.

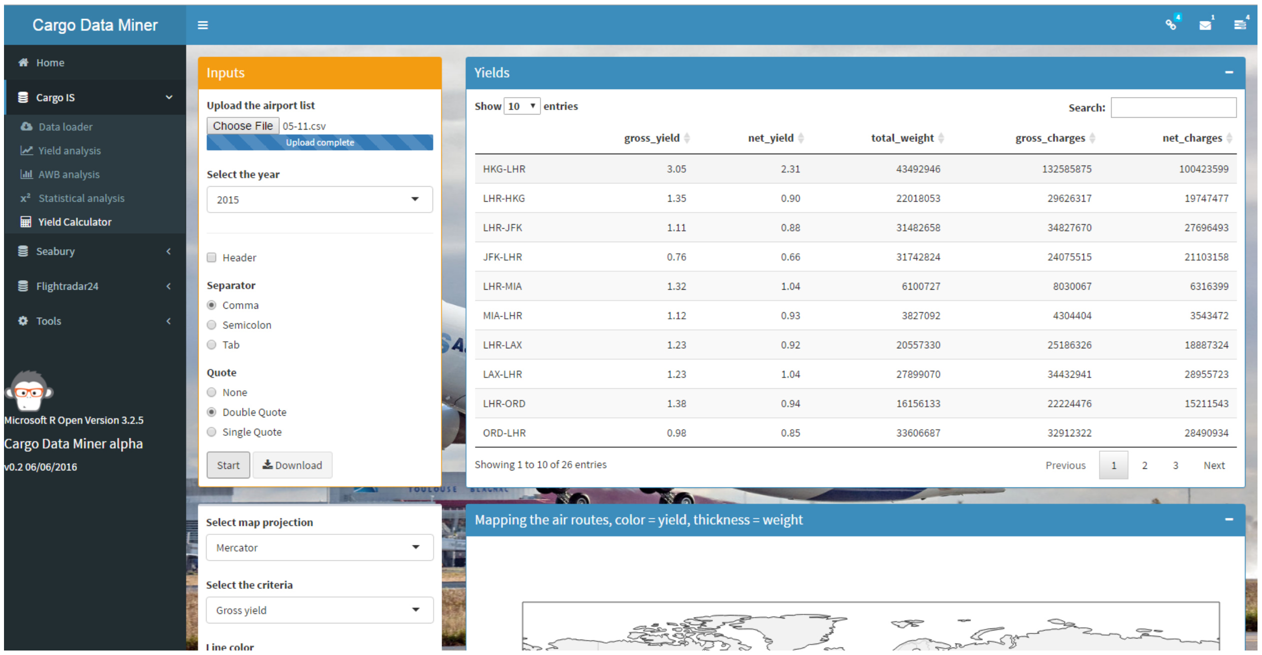
On the left of the map, there are some display parameters. You can select the appropriate map projection, the comparing criteria and some graphical parameters to customize the map.

3.1.6.2 Explaination

Figure 13 show the data manipulation procedure. Two input are used. The first one is the uploaded `csv` file and the second one is the Cargo IS data of the selected year (queried by `CargoIS.SQL.query()`). The function `grs_net_yield2()` calls the package `data.table` and computes cargo yield for every air route of this data table. The yield table will be left joined to the uploaded air route list. After merging, the data table will be displayed on the top right of the page and the function `Plot.air.route.html()` will be call to further generate a map.

3.2 Seabury Database

The second part of this document consists analysis and visualizations of **Seabury Trade** database. Seabury Trade contains annual country level cargo weight and value information. It has not only the airfeight weight and value, but also for the other surface transportation. It provide an in-depth level of commodity type which could allow us to get some knowledge about the cargo type of the market.



Upload the airport list: 05-11.csv

Select the year: 2015

[ ] Header

Separator: [✓ Comma] Semicolon Tab

Quote: None [✓ Double Quote] Single Quote

Select map projection: Mercator

Select the criteria: Gross yield

Line color

Show 10 entries

	gross_yield	net_yield	total_weight	gross_charges	net_charges
HKG-LHR	3.05	2.31	43492946	132585875	100423599
LHR-HKG	1.35	0.90	22018053	29626317	19747477
LHR-JFK	1.11	0.88	31482658	34827670	27696493
JFK-LHR	0.76	0.66	31742824	24075515	21103158
LHR-MIA	1.32	1.04	6100727	8030067	6316399
MIA-LHR	1.12	0.93	3827092	4304404	3543472
LHR-LAX	1.23	0.92	20557330	25186326	18887324
LAX-LHR	1.23	1.04	27899070	34432941	28955723
LHR-ORD	1.38	0.94	16156133	22224476	15211543
ORD-LHR	0.98	0.85	33606687	32912322	28490934

Showing 1 to 10 of 26 entries

Figure 12: Yield calculator interface

Beside Seabury trade, there two other databases which could be useful for market knowledge. They are Seabury Express and Seabury. They could be very useful for the further development of the application.

Seabury databases are stored in the same data server as Cargo IS.

3.2.1 Data loader

3.2.1.1 Instruction

As for Cargo IS query, the first step here also consists of data loading. You must select firstly the data granularity to be queried. Then, the year parameter should be set as well. Seabury Trade database contains annual data from 2000. Then the drop menus of *Origin* and *Destination* will change automatically according to your selection of data granularity. When all the input parameters are set, click on the **Run** button to start to query the database.

3.2.1.2 Explaination

The start button trigers the user-defined function `Seabury.SQL.OD.query()`. It works just like `CargoIS.SQL.query()`: it will generate a SQL query that depends on the user input. Then it send the generated query to our SQL server and fetch the returned data.

```
# Example
#' ODBC: a Oracle SQL connector,
#' level: granularity of queried data
#' ORG: Origin
#' DST: destination
#' Year: interger of NA, if NA, query all the data, otherwise query the selected year
#' country.name: if TRUE, return the full country name
Seabury.SQL.OD.query(ODBC, level, ORG, DST, year = NA, country.name = FALSE)
```

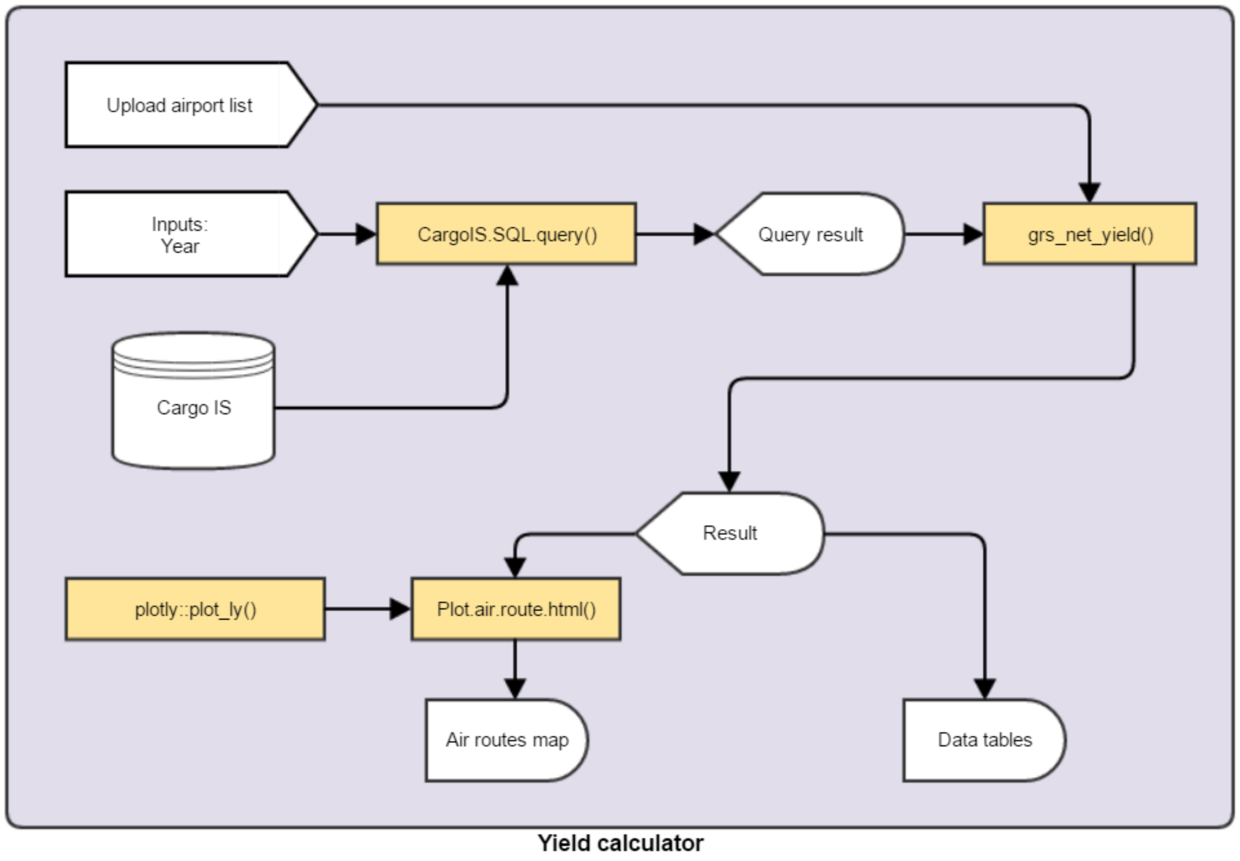


Figure 13: Flowchart of yield calculator

3.2.2 Commodity treemap

Seabury Trade database contains a detailed commodity categorization system. It has eight main categories and more than 2000 sub-categories.

3.2.2.1 Instruction

Seabury Trade has more than 70 000 000 rows so the data loading process may take longer time than Cargo IS. When data is loaded, **CDM** will generate a treemap to present the commodity types, their weight (in kg) and their value (in USD). The size of the square corresponds to the cargo weight for this type of goods. Its color represent the value. The data table could be view in the *Table* tab, and you could download it by clicking on the button *Download*. The structure of the data table is the same as the airport treemap in Cargo IS.

You can click on the square to look further into the sub-categories of the selected commodity type. There are four different levels of categories, G1, G2, G3 and G4. The bigger the number, the higher the complexity. G1 level contains eight different categories but there are around 2000 in the G4 level.

You could change to look at the ocean freight information by simply selecting the freight type from the dropdown menu. The data table is also downloadable by clicking **Download** button.

3.2.2.2 Explaination

To draw the treemap, a user-defined function `treemap_dt_sea_gvis()` is firstly called to generate a data table that fits the requests of `googleVis::gvisTreeMap()`. Then the treemap is generated with a user-defined function `treemap_sea_gvis()`, which will call `googleVis::gvisTreeMap()`.

```r
# Function to generate data table for treemap of SEABURY GXCODE
#' data: an output datatable of Seabury.SQL.OD.query()
#' if AIR = TRUE then output airfreight value
#' otherwise, output surface freight value
treemap_dt_sea_gvis(data, AIR = TRUE)

#' Function to draw the treemap of SEABURY GXCODE
#' data: Output of treemap_dt_sea_gvis()
#' ORG, DST, YEAR: parameter of the title of the treemap
treemap_sea_gvis(data, ORG, DST, YEAR)
```

3.2.3 Evolution plot

3.2.3.1 Instruction

The second major functionality of Seabury Trade tab is the cargo weight evolution plot. By selecting the name of commodity type, you can thus create a line chart that represents the evolution of airfreight weight since 2000. If the box "Plot all level" is checked, then all the data base will be loaded and visualized (This could take a very long time).

There are four sub-tabs (G1LEVEL, G2LEVEL, G3LEVEL and G4LEVEL) representing the four different catogiries. The evolution of the sub-categories (if exist) of the selected type will be plotted following sub-tab. You can change the y-axis from cargo weight to cargo value.

The data table will be displayed in the last sub-tab.

Attention: If you selected, for example, a G3 level category, then please go the the third sub-tab to get the correct line chart. The charts in the superior levels will be the same as the third tab, but the commodity name will be wrong. To know the level of category that you selected, you can count the number of "-" before the name of category.

3.2.3.2 Explaination

3.3 FlightRadar 24 Database

FlighRadar 24 (FR24) is a rencently purchased database at Airbus. It is a Swedish internet-based service that provides aircraft flight information. The database that Airbus purchased from FR24 includs flight tracks, origins and destinations, flight numbers, registration numbers, flight positions (coordinates), altitude, heading and speed during 2014 and 2015. The data of FR24 mainly comes from the third party ADS-B (Automatic dependent surveillance-broadcast) receivers all over the world. The receivers collect data from any aircraft in their local aera that are equipped with an ADS-B transponder and upload to the internet in the real time.

FR24 could be very valuable for Airbus freighter because it may fill the gap of the lack of express cargo airlines' data. In an other flight schedule database **OAG**, there is no data for express cargo airlines (like **UPS**, **FedEx** or **DHL**). However with FR24, we may be able to extract the real flight program of these airlines, which we did not have any information before.

But, comparing with other databases, it has some particularities.

- We have two stock location for this database. The first one is the **MySQL** server inside airbus (which is used by **CDM**). The second one is the cloud-based platform **Foundry** (could be queried by SparkR on Foundry).

- The data size is way larger than the other databases. Because it records the real-time position of aircraft, so we have about 1-2 Gb of data per day. **CDM** mainly uses the air routes data (which means Origin-Destination information). So I could still manipulate the data on my own desktop. But in the future, if we will need to use the position data of FR24, more computing capability will be necessairy.
- The data quality of FR24 is a major challenge for analysis. For example here I list three major problems of the database:

  1. Missing values in the data table are very frequent.
  2. There may be several different values indexing one same thing (*e.g.* In the column "Aircraft Type", both B77F, B77L, 77L and 77F represent Boeing 777 freighter).
  3. The data could be merged incorrectly at the very begining of ADS-B raw data manipulation (*e.g.* the aircraft type of an aircraft registration number is not correct). This could be a problem of FlightRadar24 raw data.

These problems should be solved through two approaches. On one hand, we must return our feedback to FR24 in order to improve the data quality in the raw data level. On the other hand, inside Airbus, we will need to find a efficient method to detect and correct abnormal values in the database (See the section *Further development* for more details.)

3.3.1 Data loader

Due to the insufficient data quality, the data loading process of FR24 will be a bit more complexe than the two previous databases. It will be done in two step.

First of all, **CDM** queries FR24 database according to user's input. Then, it will merge FR24 data with our BIO data by the registration number, in order to improve the data quality.

3.3.1.1 Instruction

To load the database, you have to precise the data range (by clicking and navigating through the data range selection panel). Then there are several parameters can be set according to the user's need (none of the following parameters is obligatory).

- Airline: Select the airline(s) that you want to query
- Origin: Filter by the origin airport.
- Destination: Filter by the destination airport.
  - If Destination is missing, **CDM** will query all the flights that leave the origin airport
  - If Origin is missing, it will query all the flights that fly to the destination airport
  - If Origin is the same as the Desination, it will query all the flights of the selected airport
  - If both Origin and Destination are missing, it will not filter the data by O&D
- Registration number: Filter by the aircraft registration number(s)
- Aircraft type: Filter by the aircraft type(s)

By modifying the parameters, **CDM** generates automatically a SQL query that corresponds to your request. And the query text is showed in the text aera. If you are familiar with MySQL, you can directly modify it in the text box to create a more customizd query. To solve the problem 1, the query will ignore all the data with a missing origin or destination.

Then click on the button **Query** to query FR24 database. The summary of FR24 data will be showed on the top right of the current tab. Then on the bottom of the page, a new box called *Data Cleaner* will appear. It will allow you to further remove the outliers in the returned data table in order to solve the problem 3.

After selecting the appropriated parameters in data cleaner box, click on the blue button **Enrich with BIO** to query BIO and merge it with the FR24 data table. The idea is to used the cleaned BIO data to replace the original data in order to solve the problem 2. A bar chart will appear on the top right showing the distribution of a selected variable. Here again, you could check the data quality and remove the outliers by looking at its frequency.

The merged data can be downloaded by clicking on the download button.

3.3.1.2 Explaination

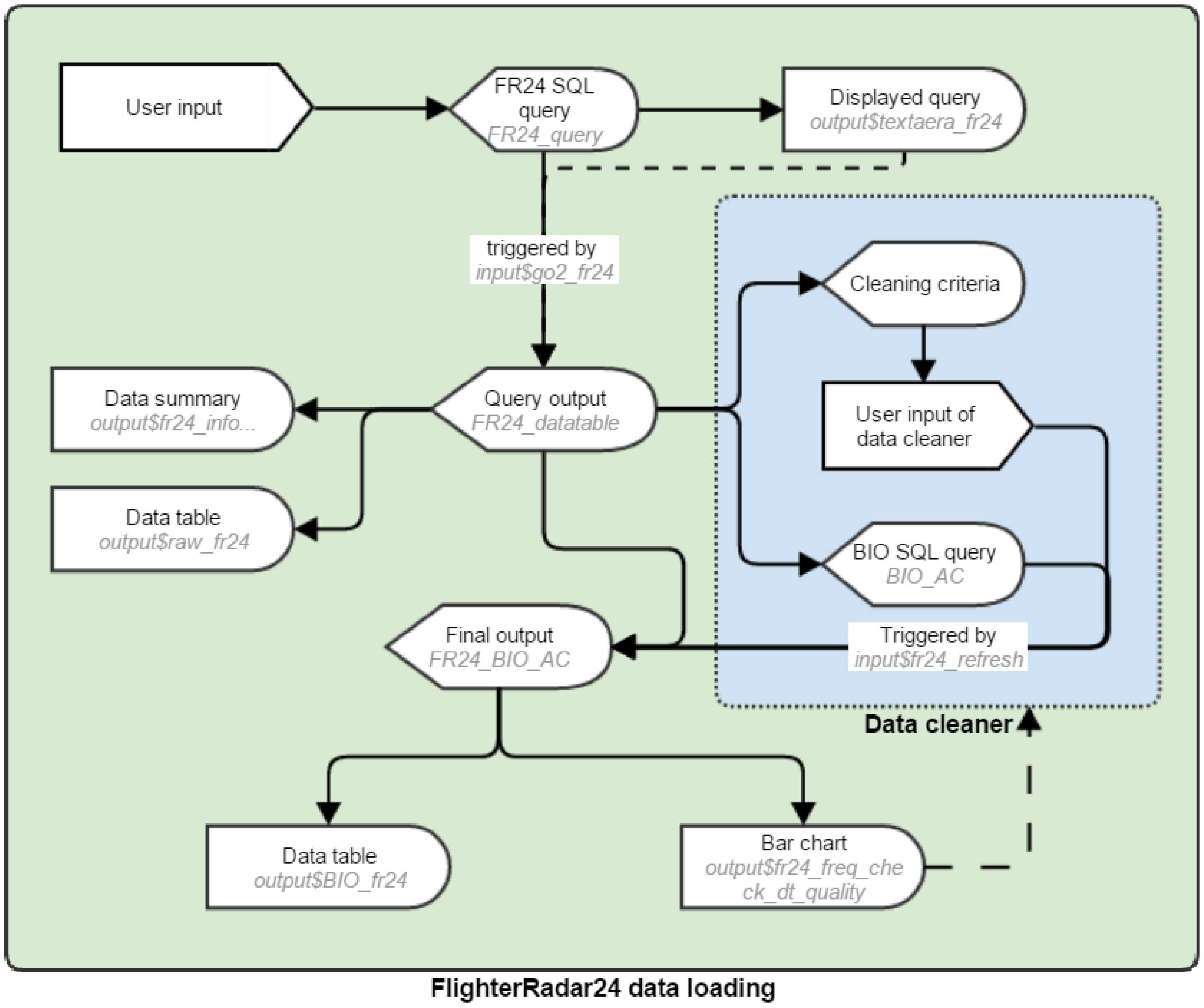


Figure 14: The data loading process of FR24

FR24 is stocked on a MySQL server inside Airbus. So the first step is to generate a SQL query that fits user's request. By using logical operators and string manipulation, the output query string is stored in `FR24_query()`. The text aera shows the content of `FR24_query()` and could be modified by keyboard. Then, when the button **Query** is clicked, `input$go2_fr24` will trigger the SQL query. The query result will be stocked in `FR24_datatable()`. The infoboxes will be created based on some descriptive statistics and the preview of data table will be returned as well.

Because of the data quality, I would like to create another filter process to detect the outliers in the data in order to further refine the data quality. The idea is to return the abnormal value in the **Data cleaner** box and let the user decide whether to keep it or not.

- Registration number: The aircraft registrations are strings containing five or six characters. To detect the abnormal value, I used the package `stringdist` to compute the **Jaro-Winkler** distance between each of these numbers. Then I cluster these registration numbers based on the distance matrix. I list the least presented clusters to the user so that the user could select and remove the incorrect values.
- The other three variables contains normally less values than the registration number, so they could by entirely listed and selected by user.

When the button **Enrich with BIO** is clicked, it will trigger the query of BIO database (**CDM** will match the BIO data by the registration number in FR24 database) and a data table containing detailed information of the aircraft will be returned and stored in `FR24_BIO_AC()`. You will see the preview of data table `output$BIO_fr24` and a bar chart `output$fr24_freq_check_dt_quality`.

3.3.2 Airline network

3.3.2.1 Instruction

A map showing the location of every airport in the queried FR24 data table will be displayed after the data loading process. You could click on the markers to see the airport IATA code and airport name. In the tab **Network Analysis**, the network of the data table will be extracted and visulaized.

Every circle on the map represents an airport. The size represents its importance in the network. All the circles are colored by their corresponding region. You can filter the airports by their regions by clicking the dropdown menu on the top left.

The arrow shows the direction of the airfreight flow.

You can click on an airport to filter all its neighbour airports (airports that are directly linked to this airport). You can also drag the circle to change its position.

3.3.2.2 Explaination

3.4 Other features

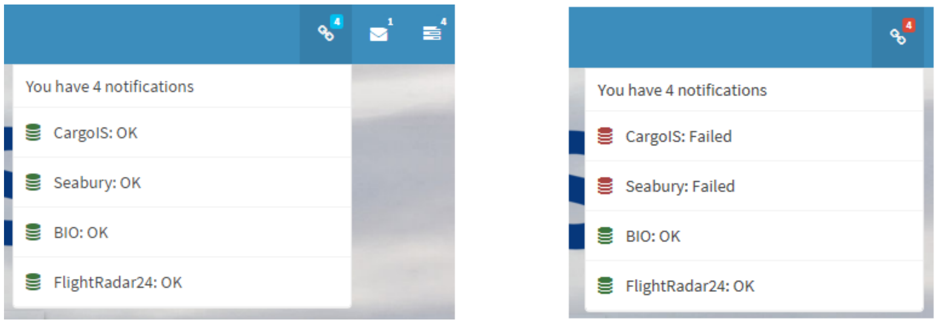
3.4.1 Connection status check

The first link icon on the top right shows the conncection status of **CDM** to the databases. If all the databases are seccesfully connected, the color around the number will be blue. Otherwise the backgroud color will turn red.

You can click on the icon to see the detailed connection information.

3.4.1.1 Explaination

Each time when a new session of **CDM** starts, it will try to make a connection to these databases and check the class of the connector by using `try()`. It will return "try error" in the case that the connection to databases could not be established.


You have 4 notifications
CargoIS: OK
Seabury: OK
BIO: OK
FlightRadar24: OK

You have 4 notifications
CargoIS: Failed
Seabury: Failed
BIO: OK
FlightRadar24: OK

Figure 15: Connection succeed/failed

```
CargoDB <- try(dbConnect(drv, username = username_cargois,
                         password = password_cargois,
                         dbname = connect_string_cargois))
```

If the class of all the connectors are not `'try-error'`, the value `OK` will be given to the variables `statu_cargois`, `statu_bio` and `statu_fr24`, which will determine the color and the text output of the header's notification.

IMPORTANT: Functions related to a database will be loaded only if the database could be reached.

3.4.2 Server-side selectize input

There are several different methods to have a reactive select input. For example `uiOutput() + renderUI({selectInput()})`. But in some situation, the input contains too many elements so that the proformence of `renderUI()` may be insufficient. In this situation, `selectizeInput() + updateSelectizeInput()` will be very useful.

```
# Example
# in ui.R
selectizeInput('foo', choices = NULL, ...)

# in server.R
shinyServer(function(input, output, session) {
  updateSelectizeInput(session, 'foo', choices = data, server = TRUE)
})
```

The server-side selectize input uses R to process searching, and R will return the filtered data to selectize. It is widely use in **CDM** and it greatly boosts the interactive performance.

3.4.3 User session log (still under development)

The idea of this feature is to create a interface where the experienced R user could get the system log information and interactive with R by coding. But now I still did not find a way to capture the R consol's output and return it into **CDM**. Now you can only call a "so-called" console of **CDM** by pressing the ~ button of your keyboard.

This feature is done by using a JS script.

```
# ui.R
fluidRow(
         htmlOutput("consol"),
         tags$script('
                     $(document).on("keypress", function (e) {
                     Shiny.onInputChange("key_track", e.which);
                     });
         ')
)


# server.R
output$consol <- renderUI({
    show = FALSE

    if(is.null(input$key_track)){

    } else if (input$key_track == 126) {
      show <- TRUE
    }

    if(show){

      HTML('<!-- HTML CODE HERE -->')

    } else {
      p('')
    }
  })
```

4 Future Development

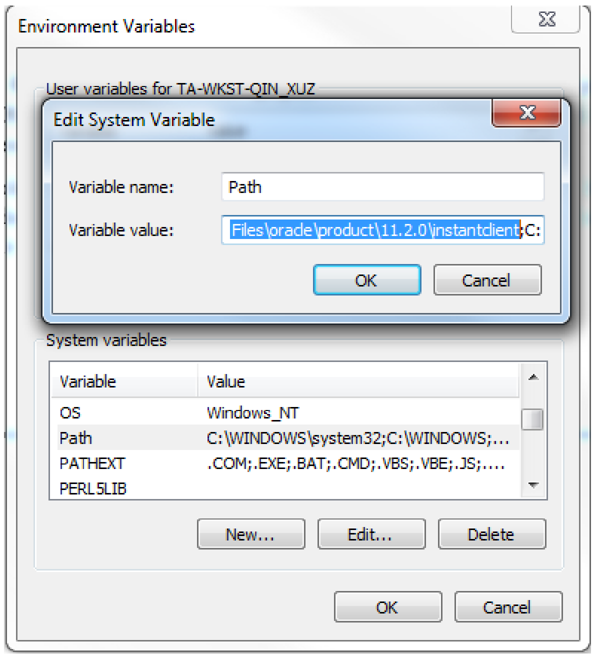
5 Appendix: Troubleshooting

5.1 Install Oracle Database instance client

Oracle Database Instant Client (11.2.0.3) EN_W764 could be found in **PC Service**, or it could be downloaded from http://www.oracle.com/technetwork/topics/winx64soft-089540.html (you may need to create an account to be able to download it). After downloading the client, extract it to a folder that you could find again.

If **CDM** could not be executed due to errors of Oracle instant client, you can check if the environment variables of Windows is set correctly by doing the following procedure.

- Open the properties window of the computer.
- Click on "**Advanced system settings**"
- Select the tab "**Advanced**" of the appearing dialog box.
- Click "**Environment Variables**" button on the bottom.
- Find the variable "**Path**", make sure that the path of your Oracle instance client is added. If not, add it.



Variable name: Path

Variable value: Files\oracle\product\11.2.0\instantclient;C:

Variable	Value
OS	Windows_NT
Path	C:\WINDOWS\system32;C:\WINDOWS;...
PATHEXT	.COM;.EXE;.BAT;.CMD;.VBS;.VBE;.JS;....
PERL5LIB	

Figure 16: Check the "Path" system variable

If the problem still exists, check the **ROracle** package installation instruction on http://cran.us.r-project.org/web/packages/ROracle/INSTALL

5.2 Download and install an R package manually

Some of the R package could not be installed directly from **CRAN**, for example the package `ROracle`. In this situation, the manuel installation will be needed.

Here I will show the installation process for `ROracle`.

- Firstly, download `ROracle_1.2-1.zip` from *oracle.com* (http://www.oracle.com/technetwork/database/database-technologies/r/roracle/downloads/index.html)
- Secondly, place the .zip file into `~/CDM/Rpackages` and make sure that *Oracle Instant Client* is correctly installed.
- Then, instead of running

```
install.packages('ROracle')
```

run

```
install.packages('Rpackages/ROracle_1.2-1.zip', repos = NULL, type="source")
```

After the installation, the package could be called by

```
library(ROracle)
```